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"Technical Support for Grassroots Public Interest Groups"

June 26, 2013

TO: Office of Environmental Information (Mail Code: 28221T)
U.S. Environmental Protection Agency
1200 Pennsylvania Ave., N.W. Washington, DC 20460
ORD.Docket@epa.gov
Docket #EPA-HQ-ORD-2013-0189

RE: Comments on Docket #EPA-HQ-ORD-2013-0189, "An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska (Second External Review Draft)," U.S. Environmental Protection Agency, Washington, DC, 910-R-12-004Ba-c, April 2013

From: Dr. Carol Ann Woody

Creation of a metal mining district in headwaters of the world's most valuable salmon fishery is a critical National decision regarding acceptable risks and trade-offs between non-renewable mineral development and our world's now rare renewable wild salmon resources. Industrialized metal mining would permanently alter and eliminate significant quantities of Bristol Bay freshwaters threatening food and economic security of the region. In North America, 73% of fish extinctions are considered due to habitat alterations.[1] Although mine proponents claim they can create and/or improve salmon habitat and prevent losses to fisheries, current status of U.S. salmon is testament to the billions spent on mitigation efforts, e.g., all U.S. Atlantic salmon populations are endangered,[2] 40% of Pacific salmon in the Lower 48 are extirpated from historic habitats,[3] and a 1/3 of remaining populations are threatened or endangered with extinction.[4] Clearly public salmon resources are not being conserved. I appreciate the effort EPA invested in this important issue and I appreciate the opportunity to comment on the EPA's revised Bristol Bay Watershed Assessment.

The BBWA synthesizes the best available science for the region, examines risks from mining, and presents information in a generally reader friendly format. Potential impacts of three mine scenarios on salmonids and subsequent effects on wildlife and Alaska Natives are examined. Reorganization and new chapters expand scope and clarity in response to peer and public review. This synthesis and conservative risk assessment will be a valuable tool for the public, policy makers, and researchers. The transparent manner in which the BBWA evolved in concert with outreach by EPA has been extremely helpful and educational to Alaskans and Americans attempting to separate fact from fiction in regards to the risks mining presents to Bristol Bay fisheries. As an Alaskan, Bristol Bay researcher, and former federal scientist (18 years, USGS, USFS, USFWS), I sincerely appreciate this independent comprehensive review and risk analysis.

The new cumulative effects Chapter (13) provides the public a more realistic picture of probable fisheries trade-offs relative to mining, specifically, development of a much larger mining district facilitated by

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[1] Miller et al. 1989.
[2] http://www.nmfs.noaa.gov/pr/species/fish/atlanticsalmon.htm
[3] National Research Council. 1996. Upstream: Salmon and society in the Pacific Northwest. National Acadamy Press. Washington D.C.
[4] Gustafson et al. 2007. Conserv. Biol. 4: 1009-1020. AND Nehlsen et al. 1991. Fisheries 2:4-21. AND Slaney et al. 1996. Fisheries. 10:20-34.

Pebble infrastructure. Such development could potentially eliminate, block or dewater more than 200 km of streams (Pebble 6.5 scenario + development of 6 smaller claims) and eliminate up to 44 km^2 of wetlands (Pebble 6.5 scenario + 6 smaller claims). Water withdrawals would impact 54 km^2 in the 6.5 Pebble; similar impacts are unclear for the cumulative impact section.

Compensatory Mitigation is now considered in Chapter 7 as well as Appendix J. Compensatory mitigation measures considered a wide range of measures ranging from beaver dam removal to hatcheries. Current status of U.S. salmon is a testament to the efficacy of billions of dollars of mitigation efforts, although well intentioned, mitigation and compensation have failed to reverse the decline of salmon and effects of mitigation at the watershed scale are not known (Bernhardt et al. 2005).

I reviewed the revised Watershed Assessment (BBWA) relative to fisheries and the following list are my perceptions of how EPA responded to the more substantive comments related to fisheries. The 2013 BBWA responds to substantive peer reviewer comments relative to fisheries including:

1) Salmonids are now clearly justified as the primary endpoint because of their subsistence and economic value - fisheries sustainability is the primary concern of stakeholders and the public.

2) The BBWA economics section values the commercial salmon fishery at approximately $300 million and 14,000 full and part-time jobs based on 2009 data.

   Recommendation: **Consider including statistics from the more recent Gnapp et al. (2013)[5], which valued the commercial salmon fishery at $1.5 billion dollars and 10,000 full time jobs.**

3) EPA acknowledges importance of non-salmon to harvest and ecology in Appendix B but focuses on Dolly Varden and rainbow trout because they are valuable subsistence and sport species, occur throughout the region, and are highly sensitive. The lack of data on other non-salmon species understandably prevents their inclusion in the BBWA.

4) Climate change is now addressed in the BBWA (Chapt. 3.8). EPA recognizes climate change will impact hydrology and increase challenges of mine water and waste management. I support the conclusions of studies cited by EPA – that maintenance of currently high salmon biodiversity will be necessary in order for salmon to adapt to future environmental change. I also agree with EPA that salmon in a Bristol Bay mining district would face triple adaptation challenges to rapidly changing habitat, decreased naturally interconnected stream and wetland systems, and changes in water quality and flow regimes as mining companies attempt to adapt water and waste management to new and likely more extreme precipitation.

5) Catastrophic impacts are now better balanced with typical routine failures; estimates of risk are based on actual mine pipeline failure rates.

6) The cumulative effects Chapter (13) provides the public a more realistic picture of probable fisheries trade-offs relative to creation of a mining district.
   Recommendation: Because it is difficult to easily determine total potential impacts to streams and wetlands by comparing Tables 13-8 and 14-2, consider including eliminated wetlands in Table 14-2.

[5] http://www.iser.uaa.alaska.edu/people/knapp/personal/2013_04-TheEconomicImportanceOfTheBristolBaySalmonIndustry.pdf

Although the BBWA presents a more realistic picture of risks and potential impacts to salmon, both are still underestimated and assumptions made are overly optimistic. The following comments are where I perceive EPA assumptions to be unrealistic relative to mine district development.

1) BBWA mine scenarios are clearly based on published plans[6] commissioned by Northern Dynasty Mines a 50% partner in the Pebble Prospect when they *tried to sell their stake in the Pebble claims.*[7] What is NOT clear in the BBWA is that the 45 year 3.8 billion ton scenario is likely the most economic initial development scenario, which is significantly larger than the newly added 0.25 billion-ton and the 2.5 billion ton Pebble mine scenarios.
Recommendation: Consider replacing the 2.5 billion ton scenario with the preferred 3.8 billion ton scenario.

2) The largest scenario considered by EPA, 6.5 billion tons, would recover just 60% of the estimated 10.8 billion ton Pebble deposit. If Pebble were fully developed it could be 40% larger than projected in the RWA with significantly higher potential impacts. **Recommendation: Consider estimating potential impacts to fisheries from the 10.8 billion ton Pebble mine scenario.**

3) The assumption that 50% of the leachate would be captured from unlined waste rock piles (Section 8.1) is too optimistic.
Recommendation: provide defensible references for this claim.

4) The assumption that culverts will be checked daily and immediately fixed if fish passage is impaired during mine operation is not realistic. Surveys of permanent Alaskan roads indicate the majority of surveyed culverts impair or block fish passage including on the: Tongass where 66% of 273 culverts were inadequate for salmon passage;[8] the Mat-Su Borough where 89% of 518 culverts were unlikely to pass juvenile salmon;[9] and the Kenai Peninsula where 82% of 270 surveyed culverts provided inadequate salmon passage.[10] In Washington state 30% of recently installed culverts were barriers to fish passage.[11] Many more miles of roads than estimated in the BBWA would have to be built to support mining, not just the mine to port road.
Recommendation: Increase likely estimates of road lineage. Make culvert impact estimates more realistic based on published Alaskan road impacts.

5) The BBWA assumes that pipeline, truck, and treatment plant spills will be quickly controlled, despite citing a recent report documenting pipeline failures at nearly all U.S. copper mines[12] and other recent spills.[13] Another example includes Iliamna Development Corporation, a contractor of Pebble Limited Partnership, who spilled about 1500 gallons of diesel on a down gradient slope 200 feet from the Iliamna River, I visited the site in July and diesel sheen was on the river and salmon were also in-river; it took over a year for site remediation.[14]

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[6] Ghaffari et al. 2011
[7] http://www.adn.com/2011/08/30/2039809/company-puts-share-of-alaskas.html
[8] Flanders, LS and J Cariello. 2000. Tongass road condition survey report. Technical Report No.00-7. Alaska Department of Fish and Game. Habitat and Restoration Division. Anchorage, AK.
[9] Mat-Su Basin Salmon Habitat Partnership. 2011. Mat-Su Salmon Passage Improvement Plan. The Nature Conservancy, Anchorage, AK.
[10] http://www.kenaiwatershed.org/restoration/culverts.html
[11] Price, D.M. et al. 2010. N. Amer. J. Fish. Mgmt. 30:1110-1125.
[12] Gestring, B. 2012. US Copper porphyry mines. Earthworks. www.earthworks action.org
[13] http://kpho.membercenter.worldnow.com/story/20763959/mining-company-settles-over-2010-pipeline-spill AND http://articles.latimes.com/1997-04-24/news/mn-51903_1_mojave-desert AND http://articles.ktuu.com/2010-05-07/sodium-cyanide_24127322 AND http://www.mineweb.com/mineweb/content/en/mineweb-fast-news?oid=188685&sn=Detail
[14] http://dec.alaska.gov/spar/perp/response/sum_fy09/090605201/090605201_sr_19.pdf

6) The BBWA assumes all Potentially Acid Generating (PAG) waste will be identified and controlled prior to mine closure but prediction, isolation and control of PAG waste is an imperfect science; many examples of where PAG has not been successfully isolated and controlled exist.[15] The volume of ore at Pebble and NDMs finding a majority of 399 samples from 65 cores were acid producing and their conclusion that "it would take about 40 years for nearly all the pre-tertiary rock to become acidic…" [16] suggests PAG management and control at Pebble will be difficult.
Recommendation: Consider including or citing Figure 5 from NDMs report (footnote 9) to show PAG of Pebble tertiary rock, a safer assumption would to consider that PAG is not completely separated from NAG and base leachate models accordingly.

7) The BBWA conservatively assumes a TSF failure of 20% tailings volume and out flow up to 30 km but reported range of tailings spills are 1% to 100%.[17] Rico et al. 2008[18] found a high correlation (r^2= 0.86) between volume of tailings at time of failure and outflow volume, and that volume was correlated to a lesser extent with run-out distance (r^2=0.57).
Recommendation: Consider impacts from a larger tailings release scenario. Consider that tailings will continue to wash down river with storms.

8) It is unclear if the BBWA includes loss of headwater streams and wetlands caused by the cone of depression resulting from pumping water from the open pit[19].
Recommendation: Consider including estimates of stream/wetland loss from cones of depression.

9) The RWA assumes that historic rates of system failures from other regions of the world are applicable to remote Alaska's relatively harsher environmental conditions. Response to the Exxon Valdez spill was delayed because booms were buried in snow. In winter when daylight is limited to a few hours and temperatures dip to -30 to -50 F and weather is bad, emergency response will be delayed and hindered.

10) The efficacy of water quality mitigation practices for fish conservation outlined in Appendix I are unclear. **Recommendation: If available, include citations and statistics of how well such mitigation practices actually work relative to open pit copper porphyry mining.**

11) Northern Dynasty criticized the BBWA for not including some mitigation techniques, e.g., water management, increasing habitat connectivity, increasing quality of off-channel habitats, etc. I reviewed their proposed mitigation measures, which are attached FYI.

12) Impacts to salmon are underestimated because many streams have never been surveyed, or only surveyed once.

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[15] EPA. 1994. Acid Mine drainage Prediction. EPA 530-R-94-036 AND Kuipers et al. 2006. Comparison of predicted and actual water quality at hardrock mines: the reliability of predictions in environmental impact statements. Kuipers and Associates, Butte, Montana AND Blowes et al. 2003. The geochemistry of Acid Mine drainage. Treatise on Geochemistry. Vol. 9:149-204.
[16] Northern Dynasty Mines. 2005. Draft Environmental Baseline Studies. Chapter 8. Geochemical Characterization and ARD/AML. pg 8-12. Available at http://dnr.alaska.gov/mlw/mining/largemine/pebble/plans/2004-reports/pr_ch08.pdf
[17] Dalpatram, A. 2011. Estimation of tailings dam break discharges. USSD Workshop on Dam Break Analysis Applied to Tailings Dams. 24-26 August. AND Rico M., Benito G., and Diez-Herrero A. (2007). "Floods from Tailings Dam Failures", Journal of Hazard Management. AND Azam, Sahid and Li, Qiren (2010). Tailings Dam Failures: A Review of the Last One Hundred Years, Geotechnical News, December.
[18] Rico M., Benito G., and Diez-Herrero A. (2007). "Floods from Tailings Dam Failures", Journal of Hazard Management.
[19] Hancock. 2002. Human impacts on the stream-groundwater exchange zone. Environmental Management 29: 763-781

I am concerned that potential impacts to fisheries from mining in the BBWA are underestimated, perhaps by magnitudes. This is a disservice to the public, who deserve to know actual tradeoffs between mining and fisheries. The 0.25 to 2.5 to 6.5 billion ton scenarios actually show likely stages of mine development, which could continue to expand to 10.8 billion tons if economic; in addition the BBWA does not consider additional impacts from the port, power plants, increased human population and infrastructure.

It is important to recognize that about one third of sockeye salmon population diversity is considered endangered or extinct[20] - Bristol Bay sockeye salmon likely represent the most abundant diverse sockeye salmon populations left in the U.S. Although mine proponents claim they can offset salmon losses via mitigation, recent studies[21] clearly question efficacy of mitigation to offset salmon losses. Although a billion dollars are spent annually in the US on salmon restoration[22] effectiveness and cumulative impact of various mitigation and restoration techniques on salmon production remain debatable at the watershed scale and can sometimes be harmful.[23]

The BBWA although very conservative, shows there will be significant trade-offs of productive renewable public salmon resources for non-renewable mineral development, a perpetual waste containment and catastrophic risk problem. Because long-term sustainability and adaptability of Bristol Bay salmon depends on maintaining the currently diverse "salmon stock portfolio" such extensive habitat loss and alteration threatens future Bristol Bay salmon biodiversity and production. We would essentially trade economic and food security represented by the public salmon resource for privately owned non-renewable mineral resources.

The science is clear. Such wide scale alterations can result in loss of salmonid biodiversity and ability to adapt to future changes. Such losses will threaten food and economic security in the region. Please use your authority under the Clean Water Act to protect Bristol Bay salmon to the maximum extent possible for future generations.

Sincerely,

Carol Ann Woody, PhD

[20] Rand, P.S. et al. 2012. PLoS ONE 7(4):e34065 at: www.plosone.org
[21] Roni et al. 2010. North American Journal of Fisheries Management. 30:6, 1469-1484.
[22] Bernhardt et al. 2005. Synthesizing U.S. river restoration efforts. Science 308:636– 637.
[23] Roni et al. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. North American Journal of Fisheries Management 22:1– 20 AND Chapman, D. W. 1996. Northwest Science 5:279–293. AND Kondolf et al. 2008. Environmental Management. 42:933–945. AND Reeves et al. 1991. Rehabilitating and modifying stream habitats. Pages 519–557 in W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society, Special Publication 19, Bethesda, Maryland.

Attachment: Critique of Northern Dynasty's Proposed Mitigation Strategies

By: Dr. Carol Ann Woody

Northern Dynasty Minerals (NDM) criticized EPA's recently revised Bristol Bay Watershed Assessment for not considering some potential mitigation strategies to offset lost salmon production from mining.[24] They claim mitigation works: "Large amounts of money continue to be dedicated towards the implementation of these kinds of measures because they work; this is settled science." There is indeed an inverse relationship between the number of salmon remaining in a region and the amount of money spent on their "enhancement" or "recovery". However, the fact that all U.S. Atlantic salmon populations are endangered (NMFS 2013), 40% of Pacific salmon in the Lower 48 are extirpated from historic habitats (National Research Council 1996) and 1/3 of remaining populations are threatened or endangered with extinction, clearly illustrates that mitigation is not offsetting losses to public salmon resources.

Many of NDMs proposed "mitigation" strategies are unproven and thus would be experimental. Others, such as adding wood and rocks to currently productive rivers make untenable assumptions (e.g., habitat now limits salmon production) and overlook the fact that most of the "successful" mitigation examples they cite focus only on trout or coho salmon, were undertaken in highly altered systems where rehabilitation was necessary to begin to restore pre-impact fish productivity, and that the majority of such projects are never quantitatively monitored or evaluated, especially over the long-term, thus claims of success are unproven. Because impacts from mining in Bristol Bay will be perpetual, it is important that any proposed mitigation or compensation provide proven perpetual benefits. This paper reviews and critiques mitigation strategies proposed by NDM (in italics).[25]

1. **Northern Dynasty (NDM): Water Management-** *Water from EPA's WWTP could be distributed in a manner that reflects the relative importance of certain locations and reaches of streams. For example, instead of arbitrarily distributing water from the WWTP equally to the NFK and SFK, water discharge could be appropriately distributed to the upper portion of UT where the greatest potential magnitude of benefit would accrue to coho salmon. Surprisingly, EPA chose to distribute no water into this watershed. Also, EPA could have ensured that sufficient water was distributed to the South Fork "Springs" area, which is the major salmon spawning area in the SFK.*

    RESPONSE CSP2 Woody: Northern Dynasty Mine (NDM) fish consultants claim to know where the highest densities of spawning salmon are located in each river by species; based on this knowledge they suggest 3 water management mitigation scenarios not considered by EPA. Their proposal to add water to Upper Talarik to provide the greatest "potential magnitude of benefit" to coho salmon is untenable based on data presented in the PLP EBD. Baseline studies are inadequate to estimate total number of spawning or rearing salmon because bias and precision of aerial counts or fry density by study section was never determined. Further potentially hundreds of kilometers of headwaters used by salmon were never surveyed. Thus their claim of knowing where to derive the greatest magnitude of benefit to coho salmon over time via water redistribution is unsupported. Further, they will be impacting all freshwater life stages of five species of salmon, which have different habitat needs in space and time. How will each species be proportionally affected and compensated for via water management?

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[24] Attachment D, Northern Dynasty Mine comments submitted in response to EPA's 2013 Revised Watershed Assessment.
[25] *Ibid.* page 70

The three water management scenarios suggested below are all untested under harsh Alaska environments to mitigate for lost fish habitat. NDM consultants suggest on page 19 Appendix D to:

1- ***NDM: Develop further impoundments to increase total water volume available to offset downstream flow reductions.*** RESPONSE CSP2 Woody: This option would likely increase impacts to salmon habitat through further damming of streams and impoundment creation in the region; no supporting documentation regarding efficacy of such a program for salmon mitigation is provided.

2- ***NDM: Creation of ice fields to recharge aquifers and increase available stream flows.*** RESPONSE CSP2 Woody: Authors cite three papers implying that this technique has been successfully implemented elsewhere in regards to mitigation for salmon habitat loss. However, review of citations does not support such mitigation for salmon. Clark and Lauriol (1997) is a study of natural groundwater recharge rates in a karst permafrost system of the Yukon and is not comparable to the alluvial, non-karst, non-permafrost Pebble region where such ice fields would have to be created, managed, and maintained – basically an unproven experiment with unknown outcome. Alamaro 1999 is an unpublished Masters thesis on the feasibility of generating and storing winter ice to meet summer water demands but was never published in the primary literature and is unavailable for review. Yoshikawa et al. (2007) is a study of natural ice fields and hydrology in the Brooks Range of Alaska, and provides no support regarding potential application or efficacy of ice field creation for manipulating stream flows in a mine-impacted environment.

3- ***NDM: Water pump-back systems or recirculation of downstream water upstream for re-release.*** RESPONSE CSP2 Woody: The non-mine influenced examples given for where this method "works" are from the Lower 48 (LA, Colorado, etc.) in highly altered systems with endangered and threatened fish populations. How this hypothetical system would work in a unique mine-impacted hydrologic unit is unknown and untested. A potentially expensive experiment with unproven utility for mitigating mine impacts under Alaska conditions. Such systems would need power, and potentially, maintenance into perpetuity. Further, no peer-reviewed before-after studies showing statistically defensible increases in salmon production as a result of these pump back projects exist.

2. **NDM: Water Management:** *EPA chose to distribute water from their WWTP via surface discharge, which would result in violations of Alaska's Water Quality Standards and change the emergence timing of juvenile salmon, resulting in potentially catastrophic juvenile mortality. EPA should have realized that using the water available to recharge and surcharge groundwater aquifers, with aquifer residence time of generally a year or more, that provide critical stream flow would have eliminated the problems identified. In addition, the default release of WWTP water to recharge and surcharge aquifers would assure that WWTP upset or shutdown would not interfere with the continuing release of water to streams from groundwater storage for extended periods.*

RESPONSE CSP2 Woody:

1. Manipulation of the complex groundwater hydrology documented by PLP consultants (Smith & McCredie 2008, Groundwater Hydrology-Mine; PLP Agency presentations 2008, Anchorage) to augment stream flows would be a large-scale experiment and could fail to achieve critical stream flows for salmon mitigation, particularly during Alaskan winters.

2. Developing water impoundments, ice fields, and pump back systems to mitigate for decreased natural river flows in Alaska are unproven. No scientific documentation on the success of such projects to increase salmon production is provided.

3. If impacts are perpetual then perpetual maintenance of proposed mitigation may be required.

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2. **NDM: Water Management:** *EPA should have recognized that the WWTP discharge could be designed to provide water chemistry concentrations that would improve the buffering capacity, primary productivity, secondary productivity, and also reduce the potential toxicity of metals at area downstream of locations where discharge water reenters the stream channels.*

   RESPONSE CSP2 Woody:

   1. Changing the water chemistry of area streams fails to recognize basic salmon life history in that salmon imprint on natal stream chemistry (Dittman and Quinn 1996), which enables them to return to and spawn in the streams to which they are adapted. Calcium ions are considered an important odorant that allow sockeye salmon to discriminate their natal stream (Bodznik 1978). Changing stream chemistry could result in salmon not recognizing their natal stream and dying without spawning or they could stray to a stream to which they are not adapted and potentially suffer higher mortality thus lowered productivity.

   2. Accurate and precise manipulation and control of stream chemistry for the large rivers that would be impacted would be a challenging difficult experiment with unknown outcome particularly during spring and fall flood seasons. And would there be water management into perpetuity?

3. **NDM: Increase Habitat Connectivity:** *EPA failed to recognize numerous opportunities in all three principal watersheds to provide fish access to existing, suitable habitats that are not currently connected to a main stem channel. Figures 5.1, 5.2, and 5.3 show representative sites in the NFK, SFK, and UT, respectively. These figures are representative of photographs displayed in the EBD in Chapters 4, 7, and 15, which EPA apparently did not review. These figures are for illustrative purposes only and are not intended to identify any specific potential mitigation site. EPA did not consider providing fish passage over a cataract currently blocking anadromous fish access to suitable habitats in tributary stream UT 1.190. Authors propose to increase fish habitat connectivity to increase salmon production potential in a number of ways.* (See pg 22-57 Appendix D, NDM response to EPA revised watershed assessment.)

   NDM: ***Removal or Modification of Seasonal Barriers (beaver dams and fish passes).***
   Beaver Dams- RESPONSE CSP2 Woody:

   1. Authors purport to have documented beaver dams blocking salmon access to upstream habitats in the Pebble project area however review of the PLP EBD shows no empirical

studies but a list of purported beaver dam “barriers” in the project area ranging from 0.2 meters to 2 meters high. Bryant (1984) showed that dams of 2 meters in height did not block salmon passage upstream and surveys in the Pebble region have documented salmon above dams higher than 2 meters (Figure 1). Further, authors failed to review the most recent literature by Devries et al. (2012), employed by one of PLPs primary consulting firms on the Pebble Project. They advocate emulating ecosystem engineering by beaver as a less expensive and disruptive fish enhancement technique relative to large-scale in-stream engineering projects. It seems reasonable based on the most recent scientific literature to not manipulate or change current beaver created habitat unless studies show unequivocally that they block fish passage or somehow impair the number of smolts produced per spawner.

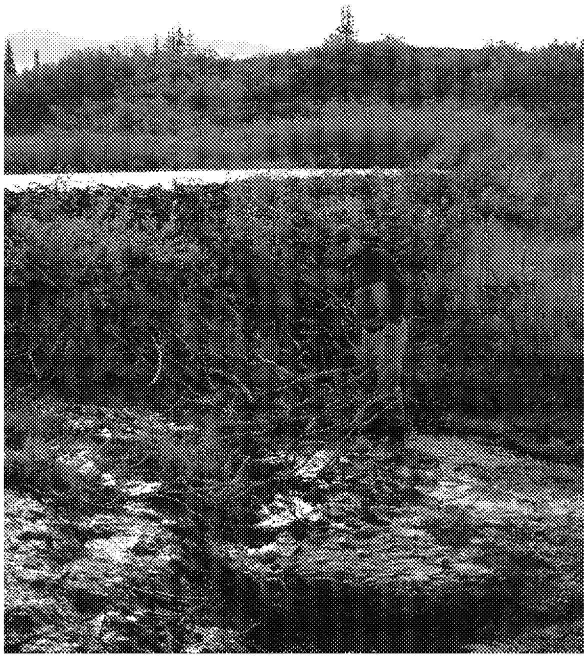

Figure 1. Upper Talarik Creek beaver dam sampled 31 Aug. 2008. Coho salmon were documented above this 2 meter high beaver dam and high densities of rearing coho salmon were documented above and below the beaver pond system.

Northern Dynasty consultants neglected to review the most recent scientific literature on the impacts of beaver dams on fishes and fish habitat. For example, Kemp et al. (2012) conducted a systematic meta-analysis of the literature and expert opinion primarily for North America. The most frequently cited benefits of beaver dams were increased habitat heterogeneity, rearing and overwintering habitat and flow refuge for fish, and invertebrate production. Benefits (184) were cited more frequently than costs (119). The majority of 49 North American and European experts considered beaver to have an overall positive impact on fish populations, through their influence on abundance and productivity. The most cited negative effect of beaver activity was that dams impeded fish passage but little research quantifying the existence or magnitude of this impact exists.

The single citation provided by NDM relative to beaver management as a mitigation tool is Finnegan and Marshall (1997) who advocate a variety of engineered structures to prevent beaver from damming culverts, which do not currently exist in the project area, as well as engineered structures to help fish pass upstream of beaver dams. Managing beaver to mitigate for lost fish habitat has questionable efficacy as beaver activity in the Pebble Project area has not been shown to reduce fish production, salmon obviously pass above beaver dams, and recent studies indicate the benefits of beaver dams outweigh the costs.

The long-term efficacy of proposed structures are not proven and not documented in the primary literature.

2. **Fish passes or Fishways**: **RESPONSE CSP2 Woody:**
Authors propose to install a fishway on a tributary to Upper Talarik Creek where groundwater from the South Fork Koktuli emerges (pg. 25, Appendix D). As a Biologist on the Tongass for 4 years one of my jobs was to maintain fish passes. Fish passes require constant maintenance, especially after floods and in areas with beaver (who will continually dam the fishway entrance); their effectiveness at passing fish is inconsistent, their effectiveness is rarely monitored and only recently studied and fishways can actually prevent or delay fish passage (Meixler 2009, Lauritzen et al. 2010, Roscoe and Hinch 2010, Hatry et al. 2011, Noonan et al 2011, Bunt et al. 2012, Williams et al. 2012). Performance of fishways varies greatly with their type, design and operating regime, and with the species involved. Of the 50 fish passes installed on the Tongass in Southeast Alaska, none are monitored to determine whether estimated fish production from installation was ever realized. Instead, managing agencies report estimated increases in fish production based on available habitat, which is very different than actually measuring increased fish production.

4. **NDM: Increase the Quality of Existing Off-Channel Habitats**: *EPA failed to recognize the potential to improve the quality of existing off-channel habitats by increasing the complexity these areas through the use of boulders, large wood, and deepening or altering the shoreline development ratio in order to create better over wintering habitat and more alcoves, and thus contributing to increased survival.*

RESPONSE CSP2 Woody:

NDM consultants propose to add boulders and large wood, as well as bulldoze new and deeper habitats to increase fish production in watersheds that would be impacted by mining. They also claim that the success of such projects is “settled science”. Such a proposal is flawed for a number of reasons. First NDM assumes that habitat is limiting salmon production and that they can somehow improve it. But these rivers already produce the world’s largest sockeye and Chinook salmon runs and there is no data to indicate habitat is limiting. But since NDM would eliminate significant amounts of salmon habitat if mining is permitted, they would have to compensate or mitigate for lost habitat. Authors overlook the fact these rivers are wild and although habitats may be disconnected at certain times of the year they are connected at other times. The photographs in attachment D on pages 72 and 73 clearly show how the rivers have moved across the landscape over time. These rivers will continue to move and any mitigation projects to “reconnect” or “improve” habitats will only affect salmon habitat temporarily. Recent science also shows such projects would have to restore 100% of eliminated floodplain and in-channel habitat to detect a fish production increase of 25% with 95% certainty (Roni 2011). The lack of statistically valid pre-mining fish abundance and aquatic biota data in the PLP EBD underscores the fact that they would be unable to show any scientifically valid increases in fish abundance in a before after study of mitigation which is one of the primary problems cited in achieving and evaluating mitigation goals (Quigley and Harper 2006a). A review in SCIENCE (Bernhardt et al. 2005) of US river restoration efforts found that although river restoration has become a highly profitable business with an average of 1 billion spent annually fewer than 10% of 37,099 projects were ever monitored post-construction to determine if objectives were realized. The outcomes of tens of thousands of projects have never been tracked over the long term thus the efficacy of such projects is equivocal. Stewart et al. (2009) found only equivocal evidence of their effectiveness at increasing salmonid abundance and significant variability in success among projects.

5. **NDM: Create New Habitats through the Development of Semi-Natural Channels:** *EPA failed to recognize the potential for development of new off-channel habitats within the three watersheds. These new channels could provide additional spawning and rearing habitats by locating them in locations where subsurface flow will provide the water to the new channel. The authors have personally reviewed and/or visited dozens of potential sites.*

   RESPONSE CSP2 Woody:

   1. Effectiveness of engineered off-channel habitats, primarily for coho salmon, was recently evaluated in British Columbia (Cooperman et al. 2006). Authors indicated that assessment of channel functionality is very limited. A rapid assessment of ten channels showed eight of ten were "functional" but five of the eight had issues that likely compromised their utility to salmon. Although authors assessed three topics 1) physical connectivity, 2) thermal stability and, 3) coho use and growth, they did not show statistically defensible augmentation of coho salmon populations in sites that were purportedly successful. Effectiveness monitoring was listed as needed to determine if off-channels actually augment salmon production.

   2. Morley et al. 2005) compared coho salmon use of constructed versus natural side channels in Washington. Total salmonid densities were not significantly different between channel types, but coho salmon densities were higher in constructed channels and trout densities were higher in natural channels in winter.

   3. Creation of spawning channels for sockeye salmon can result in disease outbreaks and reduced salmon production (Mulcahy et al. 1982)

   4. Price (2012) examined potential effects of spawning channels on Babine Lake sockeye salmon. His review indicated that increasing sockeye salmon stocks artificially using spawning channels can alter prey communities and reduce average weight of juveniles leaving the nursery lake. Marine survival rates declined with increasing numbers of emigrating salmon.

6. **NDM: Increase the Primary Productivity and Productive Capacity for Fish:** *EPA failed to recognize the potential to increase primary productivity and overall productive capacity for fish by developing an appropriate design for their WWTP so that discharges would increase key water chemistry constituents. They also failed to recognize that the entire area has very soft water and thus low productive potential. This situation could be improved through a carefully designed water chemistry enhancement program.*

   RESPONSE CSP2 Woody:

   1. Changing the water chemistry of area streams fails to recognize basic salmon life history in that salmon imprint on natal stream chemistry (Dittman and Quinn 1996), which enables

them to return to and spawn in the streams to which they are adapted. Calcium ions are considered an important odorant that allow sockeye salmon to discriminate their natal stream (Bodznik 1978) a water quality characteristic that NDM proposes to change. Changing stream chemistry could result in salmon not recognizing their natal stream and dying without spawning or they could stray to a stream to which they are not adapted and potentially suffer higher mortality thus lowered productivity.

2. There is no data on area streams and rivers showing that salmon productivity is currently nutrient limited or that nutrients affect the stock recruitment relationship (Adkison 2010).

3. Lake and stream fertilization experiments to increase primary productivity and theoretically salmon populations, assume that nutrients limit salmon production, but this is not always the case:
   -Wipfli and Baxter (2010) showed that most fish food comes from external or very distant sources, including: from marine systems borne by adult salmon, from fishless headwaters that transport prey to downstream fish, and from riparian vegetation and associated habitats.
   -Paeliolimnologic studies in Alaska indicate nutrient inputs are not always tied to higher primary productivity or salmon productivity (Chen et al. 2011).
   -Added nutrients can result in no increased fish growth (Cram et al. 2011).
   -Nutrient additions can result in nuisance algae blooms or undesireable diatoms (Hyatt et al. 2004)
   -Nutrient additions can result in declines in primary production due to changes in ecosystem metabolism (Holtgrieve and Schindler 2011).
   -Nutrient additions did not increase salmonid biomass, growth or retention in 6 California streams (Harvey and Wilzbach 2010).
   - In some systems the highest yields can be obtained from small nutrient depleted populations (Adkison 2010)

4. Accurate and precise manipulation and control of stream chemistry for the large rivers that would be impacted would be a challenging difficult experiment with unknown outcome.

7. NDM claims: "*There is no question about the effectiveness of an appropriate application of these measures to enhance production of aquatic biological resources, especially salmon. Large amounts of money continue to be dedicated towards the implementation of these kinds of measures because they work; this is settled science*." Pg. 67 Appendix D. They also rely heavily on papers by Quigley and Harper (2005, 2006a, 2006b) on Canadian mitigation to support their claims but in actuality these papers actually refute their claims.

   1. Quigley and Harper (2006a) showed that **67% of compensation projects resulted in net losses to fish habitat and only 2% resulted in no net loss.**

   2. Quigley and Harper (2006a) showed that 86% of permitted "harmful alteration, disruption of destruction to fish habitat" (HADD) in Canada had larger HADDs and/or smaller compensation areas than authorized.

3. Quigley and Harper (2006a) indicated that habitat compensation in Canada was at best only slowing the rate of fish habitat loss.

4. NDM claims that Quigley and Harper (2006a) conclude compensatory habitat development or enhancement to offset losses "is am excellent conservation strategy, potentially serving as a model for other jurisdictions", but in fact

5. Quigley and Harper (2006b) **showed that 63% of projects resulted in net losses to aquatic habitat productivity and only 25% achieved no net loss.**

6. Quigley and Harper (2006b) concluded "the ability to replicate ecosystem function is clearly limited".

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